

A REVIEW AND SUMMARY OF TRACE CONTAMINANT DATA FOR COASTAL AND ESTUARINE OREGON

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I. INTRODUCTION

1.1 Scope and Limitations

The Pacific Office of the Coastal and Estuarine Assessment Branch (CEAB) is within one of the three branches of the Ocean Assessments Division of the National Oceanic and Atmospheric Administration (NOAA). One mission of CEAB is to evaluate spatial and temporal patterns of marine environmental quality. This technical memorandum was initiated, in support of this mission, to present information on marine environmental quality in Oregon.

Marine environmental quality, as used in this report, has been given a particular working definition: only contamination or degradation of the coastal marine ecosystem by trace organics and trace metals was considered. These parameters present clear implications regarding the degree of impact upon the environment by human activities. Conventional oceanographic parameters--dissolved oxygen, temperature, pH, etc.--were not analyzed as indicators of marine environmental quality. Distinguishing natural cycles from anthropogenic impacts for conventional parameters was deemed beyond the scope of this project. The emphasis of this review was to identify areas indicative of higher degrees of contamination, primarily relative to **statewide** levels, and secondarily, relative to regional or coastal conditions.

The main purpose of this report was to draw together in one place, for the first time, all available information on trace contaminant levels in sediment, water, and biota from Oregon in the hope that sufficient data could be gathered to identify statistically significant geographic and temporal trends within the state. A secondary purpose was to begin the process of answering the question "Of what biological importance are these observed levels of contamination?" Some indication as to the relative ecological importance or impact of contamination is desired. Because essentially no information on pathological manifestations of pollution stress in Oregon was encountered, this latter goal was addressed by comparison between observed contaminant levels in Oregon and appropriate Food and Drug Administration (FDA) or Environmental Protection Agency (EPA) criteria, and by comparison with levels observed in areas of known contamination or with results of laboratory bioassay studies.

In addition to ambient environmental measures of chemical concentrations, a more direct measure of pollution was briefly reviewed: A survey of coastal point-source dischargers was made when the project was initiated to identify the scale and nature of anthropogenic inputs to the marine environment within Oregon.

In the preparation of this report, federal, state, and local agencies were surveyed as potential data sources. Also, extensive searches were made of computerized abstracts published reports, and articles. It was found that the scope of marine environmental monitoring data in Oregon has been limited to essentially five categories:

- Investigations of a suite of chlorinated pesticides,
- Surveys of dichloro-diphenyltrichloroethane (DDT), its metabolic congeners, and polychlorinated biphenyls (PCBs).
- Investigations into the levels of aromatic hydrocarbons in bivalves.
- Analyses of trace metals.
- Studies of radionuclides.

The scope of this report was limited to the first four categories. Radionuclides are largely a matter of historical interest in Oregon. At one time, gradients in radioisotopes could be observed in coastal organisms past the Oregon-California border, and out to sea as far as 200 miles. After shutdown of reactors at Hanford in 1971, levels of radioisotopes, even in the Columbia River region, have generally dropped to background concentrations (Holton, personal communication). These elements may still be important as tracers and indicators of ocean processes.

1.2 Methodology

Although extensive searches were made to retrieve all possible contaminant data for Oregon, it is not be expected that all such data has been found. This database does represent the vast majority of such environmental contaminant data. Computer searches for data references were conducted on the Dialog system through National Technical Information Service, Pollution Abstracts, Oceanic Abstracts, Aquatic Sciences and Fisheries Abstracts, and the National Environmental Data Referral Service. Theses at Oregon State University College of Oceanography were also reviewed. Numerous office contacts were made with state and federal agencies, private companies, and investigators who had previously performed research in Oregon. Some data sets obtained have never been published or reported elsewhere.

No attempt has been made at data verification with original laboratories or principle investigators (with a few exceptions). Data was accepted as printed in journals, reports, etc. Whenever possible, raw data (*i.e.*, individual samples) were used in preference to summarized data. All biotic concentrations in this report are given on a wet weight (ww) basis, unless otherwise stated. All sediment concentrations are given on a dry weight (dw) basis. All statistical analyses in this report were conducted using MINITAB or STAT-PAK Unless stated otherwise, all conclusions from statistical tests are based on a significance level (α) of 0.05 or better.

1.3 Environmental Setting of Oregon Estuaries

This report deals with the contamination of the near-shore oceanic environment, and the estuarine embayments of Oregon. For several reasons, however, the main focus of pollution assessments has frequently been on the estuarine zone. This is not only where most of man's wastes are directly discharged to the marine environment, but also the zone in which a great many of these wastes are deposited due to geophysical processes. Estuaries are biologically important zones as well. They are capable of high nutrient storage and can support great densities of biomass. They normally have a great diversity of species linked through an intricate network of predator-prey relationships. Estuaries also serve as nurseries or spawning grounds for several species of fish and shellfish, many of which are commercially harvested. These factors (plus a myriad of others) designate estuaries as critical habitats worthy of

protection. It is no surprise then that the bulk of trace contaminant investigations in Oregon have been in estuaries.

There are 17 estuaries in Oregon. A characterization of size and activities for some is presented in Table 1.1. Three estuaries stand out as having major population centers with some degree of industrialization: Tillamook, Yaquina, and Coos bays. The majority of trace contaminant analyses in Oregon come from these three estuaries plus the Columbia River estuary (which lies partially in Washington State). Maps of these four areas may be found in Figures 1.2 and 1.3.

Coos Bay is the largest Oregon estuary. It is an important industrial bay with log storage, pulp manufacturing, lumber shipment, fish processing, marinas, and other industrial uses. These activities are spread out over the various sloughs and along North Bend, the main population center. In addition to two commercial oyster beds, there is heavy recreational use of clam beds in Coos Bay.

Tillamook Bay is the second largest Oregon estuary. Major industries in Tillamook include timber and agricultural products, fish and seafood processing, and tourism. There are three commercial oyster companies plus moderate recreational clamming.

Yaquina Bay is an important industrial, commercial, and natural resource bay. Fish processing, log storage, pulp manufacturing, lumber shipment, and moderate industrial processes all occur in Yaquina Bay. Most of this activity occurs in the lower reaches of the bay, with agricultural operations up-bay.

The Columbia is the largest river on the Pacific Coast and forms the boundary between Washington and Oregon, with the majority of its estuary coming under Oregon domain (approximately three-fourths). There is heavy commercial shipping traffic of pulp, paper, and wood products, foodstuffs, petroleum products, and a wide variety of other goods through the estuary. There are major boat basins in Ilwaco, Chinook, and Skipanon Waterway, plus commercial piers in Astoria. The estuary is also a major recreational and commercial salmon fishing area. Adjacent marshlands provide valuable habitat for waterfowl.

1.4 Environmental Setting of Coastal Oregon

Three principal features of physical coastal oceanography applicable to Oregon will be briefly considered-- oceanic surface currents, upwelling, and the Columbia River Plume. These are large-scale phenomena which have great impact on ecosystem dynamics, as well as pollutant transport. For more detailed discussions, the reader is referred to Hickey (1979) for surface circulation, EPA (1971) for upwelling, and Barnes *et al.* (1972) for the Columbia River Plume. The following information has been summarized from these sources.

1.4.1 Surface Circulation

Patterns in large-scale circulation off Oregon are dominated by seasonal cycles of trade winds in the northeast Pacific. Ocean currents (and upwelling) characteristic of Oregon are driven by these trade winds, yet are highly coherent with sea level. There are two large-scale surface currents off Oregon: the California Current, a permanent feature and the Davidson Current, a seasonal flow.

The California Current is a broad, slow, shallow current flowing southward and seaward of the shelf. California Current water originates from the West Wind Drift and is basically subarctic. Definition of the current varies, but it is generally considered to be a diffuse, offshore band ranging from 200 to 500 kilometers (km) off Oregon with an average alongshore speed of 0.2 knots in summer. The current is maintained, though diminished in extent during winter, and is bracketed by northward flow on its seaward boundary and a seasonal northward flow (the Davidson Current) on its landward boundary.

The Davidson Current is a seasonal, northward surface current flowing alongshore and inside of the California Current (*i.e.*, along the slope) with a minimum width of 50 miles, and is a countercurrent to the California Current. The driving force of the Current is local wind stress resulting from the south-southeasterly trades during winter. It has been hypothesized that the flow is a surface expression of the California Undercurrent. Its maximum speed varies from 0.5 to 0.9 knots, depending on the strength of winter winds. The Current begins to develop off the Oregon-Washington coast in September, and is well established by January. It wanes again in spring, disappearing by May.

1.4.2 Upwelling

During the summer season, when trade winds are consistently from the north-northwest, there is considerable transport of surface water offshore (to a depth of 10 to 20 meters) by Eckman dynamics. "Replacement" water for this transport is a subsurface counterflow of deep water that moves onshore, then up into the surface layer. This cycling of water results in the upwelling characteristic of the Oregon coast. The signature of this upwelled water mass is high nutrient content, low temperature, low dissolved oxygen, and high salinity.

Off Oregon, upwelling is of sufficient scale to bring the seasonal pycnocline to the surface, forming a surface front from about 10 to 20 km offshore. Waterborne pollutants, floating or particulate, may be concentrated along these fronts.

1.4.3 Columbia River Plume

In the coastal region of Washington and Oregon, the Columbia River is a major influence on the physical oceanography of the continental shelf. In late summer, the Columbia accounts for more than 90 percent of the freshwater drainage entering the seas between San Francisco Bay and the Strait of Juan de Fuca; in winter, this decreases to slightly over 60 percent. Because of the enormous drainage basin, over 670,000 km², and the inland nature of this basin, cycles of the Columbia River Plume are not synchronous with those of other coastal rivers. Most coastal systems experience their peak flow in fall or winter. The Columbia's peak discharge of 21,000 meter³ per second, the result of interior snowmelt, is attained by May or June.

The Columbia River Plume maintains its identity for hundreds of kilometers as it moves under the influence of local winds and oceanic currents. The scale of dominance of the Plume in the north Pacific may be seen in surface salinities during summer (Figure 1.4B). Dissolved and suspended contaminants associated with the Columbia River may be expected to follow the general direction of the Plume, though not necessarily for the full distance the Plume is detectable.

The Plume shifts from north to south seasonally according to the influence of the Davidson and California Currents. During winter, the Plume hugs the Washington coast to as far north as the Strait of Juan de Fuca. In summer, it drifts to the southwest. The vertical extent of the influence also shifts seasonally. Depending on river flow, the Plume extends down 40 to 60 meters.